IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Inventors: Naoyasu MIYAGAWA, et al. Art Unit TBD

Appln. No.: Not Yet Assigned Examiner TBD

Filed: July 22, 2003

For: MULTICARRIER TRANSMISSION METHOD AND APPARATUS

PETITION TO MAKE SPECIAL

Assistant Commissioner of Patents
Washington, DC 20231

Sir:

The Applicants respectfully petition that the above-captioned application be granted special status. The requirements of MPEP section 708.02(VIII) are complied with as follows:

(1) Please charge the petition fee set forth in 37 CFR 1.17(i) to Deposit Account No. 19-4375.

(2) All pending claims (claims 1-10) of the present application are believed to be directed to a single invention; if the Office determines that all the claims presented are not obviously directed to a single invention, the Applicants agree to make an election without traverse as a prerequisite to the grant of special status.

(3) A pre-examination search has been made, and an Information Disclosure Statement directed thereto is attached. The field of search is:

Class 455, subclasses 91, 114.2, and 114.3;

Class 375, subclasses 140, 141, 146, 260, 296, and 297; and

Class 370, subclass 497.

(4) One copy each of the prior art deemed most closely related to the subject matter encompassed by the claims is of record in the form of the art cited in the Information Disclosure Statement filed on July 22, 2003, and in the enclosed Information Disclosure Statement, submitted herewith.

(5) The following includes a general discussion providing an overview of the art cited in the above-mentioned Information Disclosure Statements, and a detailed discussion pointing out how the instant claimed subject matter is patentably distinguishable thereover.

Sato (US 5,751,705) discloses a code division multiple access (CDMA) base station transmitter that suppresses a peak while transmitting. The transmitter has spread units that spread transmission data of communication channels, by different spreading codes, to generate spread signals. A summing synthesizer sums the spread signals generated by the spread units to output a multiplexed spread signal, and a limiter amplitude limits the multiplexed spread signal output from the summing synthesizer. Preferably, the limiter is composed of a read-only memory (ROM)

that is addressed by the multiplexed spread signal to obtain an amplitude limited multiplexed spread signal.

Lomp et al. (US 2002/0118729) disclose an automatic power control system for CDMA communications in which a receiver receives signals and noise over a frequency spectrum of a desired spread spectrum signal. The received signals and noise are demodulated to produce a demodulated signal that is despread using a code unrelated with the code used to spread the received signal. Thereafter, a power level of the despread, demodulated signal is measured as an estimate of the noise level of the frequency spectrum.

Yoshida (US 2003/0063685) discloses a coding method for multi-carrier transmission and encoder that provides peak power suppression for a 2^m state amplitude/phase modulated signal. According to this method, the modulation phase space is divided into $2^{m'}$ groups, where $m > m'$. Each representative point in the $2^{m'}$ groups is regarded as a $2^{m'}$ phase shift key (PSK) signal point and has a maximum amplitude level. From the divided phase space, a pair of signal points is selected such that the summation of phase difference $\Delta\theta$ ($0 \le \theta \le 2\pi$) between the pair is π.

Hunton (US 2002/0006157) discloses a spread spectrum communication system that receives spread spectrum symbols, corresponding to a plurality of combined separate data channels, to

be transmitted by the system. The communication system includes a filter for filtering the symbols before their transmission and a peak reduction unit coupled between a source of the spread spectrum symbols and the filter. The peak reduction unit receives the spread spectrum symbols from the spread spectrum symbol source and predicts the effect of the filter on the symbols, using the filter coefficient values corresponding to the filter impulse response function. Based on the predicted effect of the filter, the peak reduction unit performs peak reduction processing only on those spread spectrum symbols expected to cause the filter output to exceed a predetermined peak limit value. The peak reduction unit then provides processed symbols to the filter for filtering and subsequent transmission by the communication system.

McGowan et al. (US 2002/0012403) disclose an envelope magnitude predictor that receives multiple pairs (i.e., I and Q signals) of baseband signals. Each pair of baseband signals is input to a pair of signal squarers and the output of the signal squarers is input to respective adders. Each set of signal squarers and adders are equivalent to a squared envelope magnitude predictor. The envelope magnitude predictor further includes square root blocks respectively connected in series with the adders. The outputs from the square root blocks represent the envelope magnitudes corresponding to the respective baseband

signals. The outputs of all the square root blocks are combined by another adder to generate a combined envelope magnitude approximation. This approximation is representative of the worst case magnitude of the envelope generated after all baseband pairs are quadrature modulated and combined and is used to generate a scaling factor that reduces peak power spikes of the quadrature modulated signals.

Leva et al. (US 2002/0061068) disclose a method of reducing the peak-to-average (PAR) power ratio of a multi-carrier signal in a transmission system. According to this method, a Fourier transform is applied to a digital signal to obtain a modulated signal. Then, an anti-peak signal, composed of a pulse train of Gaussian-shaped pulses, is summed in phase opposition with the modulated signal to reduce the PAR power ratio of the multi-carrier signal.

Wright et al. (US 2002/0101935) disclose a post-conditioning circuit that generates a de-cresting pulse that can decrease the amplitude of a signal peak of a composite multi-carrier signal. The composite multi-carrier signal includes a plurality of input symbol streams that are pulse-shaped and frequency upconverted to a plurality of upconverted streams. The post-conditioning circuit includes a comparator, a weight generator, an impulse generator, a multiplier circuit, and a bandpass filter.

The comparator compares the composite multi-carrier signal to a predetermined threshold and activates an output when the signal exceeds the predetermined threshold. The weight generator receives the plurality of upconverted streams and phase information from a plurality of oscillators. The weight generator also receives carrier waveforms for the plurality of upconverted streams so that it can determine an upconverted stream's contribution to the composite multi-carrier signal's peak. The weight generator calculates a weight value for each upconverted stream approximately proportionate to the upconverted stream's contribution to the composite multi-carrier signal's peak. The impulse generator provides an impulse of a controlled duration in response to the output of the comparator. The multiplier circuit multiplies the weight value from the weight generator and the impulse from the impulse generator to generate a scaled impulse. The bandpass filter filters the scaled impulse to a frequency band that corresponds to the upconverted stream's allocated frequency band so as to generate the de-cresting pulse.

Wright et al. (US 2002/0101936) disclose a waveshaping circuit that digitally modifies data in a data stream to decrease the amplitude of signal peaks in a waveform. The waveshaping circuit includes a preconditioning circuit, a pulse generator, a delay circuit and a summing circuit.

The preconditioning circuit receives an input symbol stream and compares data in the stream to a first reference. The preconditioning circuit modifies the data in the input symbol stream by applying to it a first impulse selected to reduce the magnitude of a signal peak in the waveform, when the input symbol stream exceeds the first reference. The preconditioning circuit further provides the modified symbol stream as an input to a pulse-shaping filter, which maps the modified symbol stream to a baseband stream. The pulse-shaping filter is configured to provide the baseband stream to a mixer, which upconverts the baseband stream by multiplication with an oscillator signal to an upconverted signal.

The pulse generator receives the upconverted signal and receives phase information from the oscillator. The pulse generator generates a band-limited pulse, such as a Gaussian pulse, a Square Root Raised Cosine pulse, a Raised Cosine pulse, a Sinc pulse, and the like, when the pulse generator detects the upconverted signal has a signal crest above a predetermined threshold.

The delay circuit is configured to delay the upconverted signal to a delayed upconverted signal, where the amount of delay is approximately equal to a latency in the pulse generator. The summing circuit is adapted to sum the band-limited pulse, from the

pulse generator, with the delayed upconverted signal, from the delay circuit, to decrease the amplitude of signal peaks in the waveform.

Hunton (US 2003/0012292) discloses a peak reduction unit adapted for use in a communication system. The peak reduction unit includes a first signal path and a second parallel signal path. The first signal path receives and delays a band limited input signal. The second parallel signal path also receives the band limited input signal, calculates a peak reduction correction factor for the band limited input signal, and filters the peak reduction correction factor. Then, the filtered peak reduction correction factor and the delayed input signal are combined to provide a peak adjusted output signal.

Kim et al. (US 2003/0086507) disclose a soft clipping technique for reducing the PAR of an input signal. The input signal may be a composite signal having one or more information bearing signals respectively centered at carrier frequencies therein. A window is created from a set of samples of the input signal such that a highest signal peak from the sample set is located in the window. Once identified, the highest signal peak for the window may be reduced by adding a threshold-correcting signal to it. A number of windows may be created from the set so

that multiple signal peaks may be reduced by corresponding threshold correcting signals.

Schilling (US 5,093,840) discloses an adaptive power control (APC) apparatus used in a spread-spectrum transmitter of a mobile station. The mobile station receives a generic spread-spectrum signal and an APC-data signal transmitted by a base station. The mobile station has an acquisition circuit for acquiring and decoding the generic spread-spectrum signal and a detector for detecting a received power level of the generic spread-spectrum signal. Additionally, the mobile station has a decoder for decoding the APC-data signal as a threshold and a differential amplifier for generating a comparison signal by comparing the received power level to the threshold. A variable-gain device of the mobile station adjusts its transmitter power level in response to the comparison signal.

Wheatley, III et al. (US 5,107,225) disclose a closed loop automatic gain control (AGC) circuit. The AGC circuit has an amplifier that receives an input signal, which is susceptible to variations in signal power. The amplifier also receives a control signal and is responsive to the control signal such that it amplifies the received input signal as a linear function of the control signal. A measurement device coupled to the amplifier measures the logarithmic signal power of the input signal and

produces a measurement signal in response to power variations of the input signal. An integration device receives the measurement signal and a reference signal corresponding to a desired signal power of the amplified input signal. The integration device integrates over time the difference between the measurement signal and the reference signal to generate the control signal.

Katznelson (US 5,125,100) discloses a system for generating a composite signal having a plurality of harmonically related signals. This system includes a signal generator that generates an arbitrarily selected plurality of harmonically related, receivable signals, whereby the receivable signals have frequencies that are integral multiples of a preselected fundamental frequency. A signal generator generates a selected plurality of harmonically related, auxiliary signals that have frequencies which are integral multiples of the fundamental frequency. Also, the frequencies of the auxiliary signals are selected so that they are different from the frequencies of the receivable signals and so that the peak-to-peak amplitude of the composite signal is less than that obtained from only combining the receivable signals. A signal combiner combines the receivable signals and the auxiliary signals to form the composite signal.

Cowart (US 5,357,541) discloses a transceiver for transmitting and receiving digital data in a network environment. The

transceiver includes both transmitter and receiver sections. The transmitter section is used for encoding a digital bit stream to a direct sequence spread spectrum signal and transmitting the direct sequence spread spectrum signal to another transceiver within the network. Additionally, the transmitter locks the digital bit stream, a predetermined spread spectrum chip sequence, and a carrier signal using binary phase shift keying modulation techniques. The frequency of the carrier signal, chip sequence, and the bit stream are all derived from, and integrally related to, an accurate reference frequency, which is produced by a crystal oscillator circuit. By deriving and relating the encoding signals in this manner, Cowart states that the receiver section of the transceiver can rapidly acquire and decode the transmitted signal.

Lomp et al. (US 5,799,010) disclose an automatic forward power control (AFPC) system, and an automatic reverse power control (ARPC) system. The AFPC system operates by measuring, at a subscriber unit, a forward signal-to-noise ratio of the respective forward channel information signal. From this measurement, the AFPC system generates a respective forward channel error signal corresponding to a forward error between the respective forward signal-to-noise ratio and a pre-determined signal-to-noise value. The subscriber unit transmits the forward channel error signal as part of a reverse channel information signal to a radio carrier

station. The radio carrier station includes multiple AFPC receivers for receiving the reverse channel information signals from multiple subscriber units and extracting the forward channel error signals from the respective reverse channel information signals. Using the respective reverse channel information signals, the radio carrier station adjusts the forward transmit power level of each of the corresponding forward spread-spectrum signals.

Lomp et al. (US 5,991,329) disclose an APC for spread-spectrum communications that includes an AFPC system. In the AFPC system, each subscriber unit measures a forward signal-to-noise ratio of a respective forward channel information signal to generate a respective forward channel error signal. The generated forward channel error signal includes a measure of the uncorrelated noise in the channel and a measure of the error between the respective forward signal-to-noise ratio and a pre-determined signal-to-noise value. A control signal is generated from the respective forward channel error signal and transmitted to a base station as part of a respective reverse channel information signal. The base station has AFPC receivers that receive respective reverse channel information signals and extract the forward channel error signals to adjust the power levels of the respective forward spread-spectrum signals.

Rha (US 6,188,732) discloses a digital feed-forward amplification system having a first branch that includes a digital combiner circuit. The digital combiner circuit receives a digital input signal that is used to generate a digital composite output signal. A digital-to-analog converter (DAC) circuit within the first branch receives the digital composite output signal and converts it to an analog composite output signal. A modulation circuit within the first branch receives a local radio frequency (RF) signal and the analog composite output signal and generates a modulated RF signal. A power amplifier within the first branch amplifies the modulated RF signal to produce an amplified RF output signal.

The digital feed-forward amplification system also has a second branch. This second branch includes a distortion correction circuit that receives the digital composite output signal from the digital combiner circuit and generates a correction signal that is used by a combiner circuit to at least partially cancel a distortion signal introduced into the amplified RF output signal by the power amplifier in the first branch.

Jones et al. (US 6,307,892) disclose a communication device for simultaneously transmitting information on multiple sub-channels. The communication device encodes information for each of the multiple sub-channels with a coding scheme to produce

channel encoded information. A mask vector derived from a redundancy in the coding scheme is used to encode the channel encoded information into code words having pair-wise Euclidean distance properties identical to those of the channel encoded information. Modulation of the sub-channels produces a composite signal envelope having a peak-to-mean error power ratio (PMEPR) reduced relative to a PMEPR for correspondingly modulated channel encoded information.

Dafesh (US 6,430,213) discloses a quadrature product subcarrier modulation system that applies subcarrier modulation to quadrature modulated signals with a constant envelope modulation suitable for efficient sinewave and squarewave subcarrier modulations. Accordingly, new signals may be added to the in-phase and quadrature-phase signals with spectral isolation while maintaining a constant amplitude waveform.

JP 09-018451 discloses a digital baseband processing part having multiple spreading devices that perform direct spreading of channel transmission data, whereby each channel is spread with a different code. An addition synthesis device adds the outputs of the spreading devices to produce a synthetic spreading signal, and a limiter limits the amplitude of the synthetic spreading signal so that it does not exceed a prescribed value. A roll-off filter limits the spectrum of the amplitude limited synthetic spreading

signal to produce a digital baseband signal. And an analog baseband/RF device: (1) converts the digital baseband signal to an analog signal using a digital-to-analog (D/A) converter, (2) modulates a carrier using the analog signal, and (3) amplifies the modulated carrier signal before transmitting it through an antenna.

JP 11-313042 discloses a peak power detection circuit that detects peak power exceeding a threshold in a signal obtained by addition processing of orthogonally modulated signals. If the detected peak power exceeds the threshold, a target value at which correction is performed is calculated and is communicated to a correction coefficient calculation circuit. Correction is performed by amplifying the inputs provided to band limiting filters with a correction coefficient.

JP 2002-164799 discloses a transmission power controller for outputting transmission data through a band-limiting filter. The transmission power controller includes a branching means for branching the transmission data to both a delay means and a peak detection filter, which has the same constitution as the band-limiting filter. A calculating means calculates a correction value for suppressing the power peak of the transmission data, based on the characteristics of the transmission data passed through the peak detection filter. After the delay means delays the transmission data passing through this branch for the amount of

time required to calculate the correction value, a correcting means corrects the delayed transmission data using the correction value and provides the corrected transmission data to the band-limiting filter.

JP 2002-044054 discloses a combination carrier transmission device having a limiter circuit. When multiple carriers are transmitted from a base station, the limiter circuit calculates the ratio of momentary power to average power of a signal obtained by multiplexing all of the carriers. This ratio is compared with a reference value. Based on the comparison, a limit factor calculation circuit outputs a limit factor suitable for a degree to which clipping is required. Limit multipliers clip the multiplexed signal using the calculated limit factor.

Applicants' claim 1 recites a method of suppressing a peak of a multi-carrier transmission signal. According to this method, filtering processing is performed on each of multiple baseband signals that respectively correspond to a plurality of frequency channels. The signals subjected to the filtering processing are each multiplied by a predetermined carrier to be single-carrier signals, and the single-carrier signals are combined to obtain a multi-carrier transmission signal. These operations of filtering, multiplying, and combining are performed in a regular signal processing route.

Additionally, each of the baseband signals is branched from the regular signal processing route to an auxiliary route. Along this auxiliary route, each of the branched baseband signals is filter processed, multiplied by the same carrier as the predetermined carrier at the same timing as in multiplication by the predetermined carrier, and combined to obtain a multi-carrier signal for use in calculating a correction value for peak suppression. An instantaneous peak of the multi-carrier signal generated for use in calculating the correction value is detected. Based on the detection result, a correction value for peak suppression is obtained. Then, each of the baseband signals on the regular signal processing route is multiplied by this correction value to provide peak suppression.

The references cited above, either alone or in combination, fail to disclose or suggest the combination in claim 1 of: (1) branching each of the baseband signals from a regular signal processing route, performing filtering processing on each of the baseband signals branched, multiplying each of the baseband signals branched by the same carrier as the predetermined carrier at the same timing as in multiplication by the predetermined carrier, combining the signals obtained, and thereby obtaining a multicarrier signal for use in calculating a correction value for peak suppression; (2) detecting an instantaneous peak of the

multicarrier signal for use in calculating the correction value, and based on the detection result, obtaining the correction value for peak suppression; and (3) multiplying each of the baseband signals on the regular signal processing route by the correction value to perform correction for peak suppression.

Independent claim 3 recites a multi-carrier transmission signal generating circuit having a peak suppressing function. This circuit includes a regular signal processing route for branching baseband signals, each corresponding to a respective one of multiple frequency channels, that are to be multi-carrier transmitted in two signal sequences. The regular signal processing route performs the operations of delaying each of the baseband signals in one signal sequence in a delayer, multiplying each of the signals by a correction value for peak suppression in a multiplier, performing n-time (n is an integer of two or more) interpolation processing on each of the signals multiplied by the correction value, processing the signals using a filter, multiplying each of the signals by a carrier to obtain single-carrier signals, and combining the single-carrier signals to output a multi-carrier transmission signal.

The circuit also includes a correction value generating route for performing on each of the baseband signals in the other signal sequence substantially the same processing at substantially the

same timing as the n-time interpolation processing, the filtering processing, and processing of multiplying by the carrier to obtain a single-carrier signal in the regular signal processing route. Thereby, a multi-carrier signal is obtained for use in calculating the correction value, detecting an instantaneous peak of the multi-carrier signal for use in calculating the correction value, and obtaining the correction value for peak suppression based on the detection value to provide to the multiplier in the regular signal processing route.

The references cited above, either alone or in combination, fail to disclose or suggest the combination in claim 3 of: (1) a regular signal processing route for branching each of baseband signals corresponding to each of frequency channels to multicarrier-transmit to two signal sequences, delaying each of baseband signals in one signal sequence in a delayer, multiplying each of the signals by a correction value for peak suppression in a multiplier, performing n-time (n is an integer of two or more) interpolation processing on each of the signals multiplied by the correction value, performing filtering processing on the signals using a filter, multiplying each of the signals by a carrier to obtain single-carrier signals, and combining the single-carrier signals to output a multicarrier transmission signal; and (2) a correction value generating route for performing on each of

baseband signals in the other signal sequence substantially the same processing at substantially the same timing as the n-time interpolation processing, the filtering processing, and processing of multiplying by the carrier to obtain a single-carrier signal in the regular signal processing route, thereby obtaining a multicarrier signal for use in calculating the correction value, detecting an instantaneous peak of the multicarrier signal for use in calculating the correction value, and obtaining the correction value for peak suppression based on the detection value to provide to the multiplier in the regular signal processing route.

Independent claim 5 recites an adaptive peak limiter having a plurality of hard limiters which are provided respectively for a plurality of frequency channels having a possibility of containing communication data to which a predetermined data packet transmission scheme is applied. The hard limiters limit an amplitude value of a baseband signal of each of the frequency channels using an adaptive limit value provided from outside. The adaptive peak limiter also includes a limit value table to which access is made using, as an address variable, on/off bit information indicative of whether the predetermined data packet transmission scheme is applied and another on/off bit information indicative of whether each of the frequency channel is used. Both types of information are reported from an upper layer for each of

the frequency channels. The limit value table outputs an adaptive limit value as a result of the access to provide to at least one of the plurality of hard limiters.

The references cited above, either alone or in combination, fail to disclose or suggest the combination in claim 5 of: (1) a plurality of hard limiters which is provided respectively for a plurality of frequency channels having a possibility of containing communication data to which a predetermined data packet transmission scheme is applied, and limits an amplitude value of a baseband signal of each of the frequency channels using an adaptive limit value provided from outside; and (2) a limit value table to which access is made using, as an address variable, on/off bit information indicative of whether the predetermined data packet transmission scheme is applied and another on/off bit information indicative of whether each of the frequency channel is used, both the information being reported from an upper layer for each of the frequency channels, and which outputs an adaptive limit value as a result of the access to provide to at least one of the plurality of hard limiters.

Applicants submit that the references discussed herein, considered alone or in combination, fail to disclose or suggest the claimed subject matter. Therefore, in light of the foregoing discussion pointing out how the claimed invention distinguishes

over these references, Applicants respectfully submit that the inventions of independent claims 1, 3, and 5 and all claims dependent therefrom are not anticipated by these references and would not have been obvious over any combination thereof.

Grant of special status in accordance with this petition is respectfully requested.

Respectfully submitted,

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